

A full-page background image showing a soldier in silhouette, aiming a rifle. The soldier is in the foreground, and the background is a dark night sky with a large, bright full moon. The title text is overlaid on the upper part of the image.

Making ***AMERICA'S ARMY***

The wizardry behind the U.S. Army's hit PC game

By Margaret Davis, Russell Shilling,
Alex Mayberry, Phillip Bossant,
Jesse McCree, Scott Dossett, Christian
Buhl, Christopher Chang,
Evan Champlin, Travis Wiglesworth
and Michael Zyda



Drop your sword. A combat brigade bursts from a Stryker in the **AA** online game



During the Vietnam war, the U.S. military suffered a loss of prestige among youth from which they could never quite recover. A generation that had grown up admiring WWII heroes had begun to see the armed services as, at best, an embarrassment, and at worst, the enemy.

Although recruiters tried on a number of appeals over the last thirty years (“Be All You Can Be,” “Get an Edge on Life,” “An Army of One,” etc.), these campaigns failed to resonate with their audience because they no longer spoke the language of the young. Until recently, enlistment fell short of annual goals.

If the horrors of the 9/11 attack raised national consciousness that there really are bad guys and they really are out to get us, the liberation of Iraq, with its kick-ass technology and compassionate commandoes, did much to prick curiosity about the work and ethos of national defense. The videogame *America's Army* (AA) was constructed to field such curiosity. While work on the game began well before 9/11, its timing as a mediator of Army culture to game-playing teens has been ideal. The integrity displayed by American soldiers in the deserts and cities of Iraq is explicated in the game (and indeed is central to the plot), and the dangerous missions and cool gear so beloved of young men are represented with authority and gusto. With AA, the Army again speaks to teens in their native tongue.

The project seemed unlikely. That the Army would issue a videogame offering free, networked, no-cookies play online for all comers was dubious; but if so, one could only expect—face it—a stodgy misfire, outdated months, if not years, before release. So when AA debuted as a world-class contender at E3 2002—sharp, immersive, informative, exciting—it was dissonance inducing. AA was a surprise attack worthy of any mission in the game.

AS A PRODUCT of the behemoth that brought you thousand-dollar toilet seats, it might be supposed that AA was researched exhaustively in conception and choked with money and personnel in gestation, and struggles today against zealous over-protectionism. Not so. The idea came to a West Point instructor, Colonel Casey Wardynski, at a cocktail party: why not build a video game to help recruitment? Kids don't know beans about the Army anymore; why not educate them in a way they'll enjoy, allowing those who might be interested to identify themselves?

At the Naval Postgraduate School in Monterey, California, a computer scientist was thinking the same thing. Professor Michael Zyda had been up to his elbows in digital graphics for a couple of decades, knew everyone in the military, industry, and academia. He had organized the MOVES Institute for modeling, virtual environments, and simulation in response to a National Research Council call to arms and was avid for worthy projects. An NPS graduate connected them; the two agreed it could (and should) be done; and they found funding.



Special Forces soldier on CSAR (combat search-and-rescue) mission



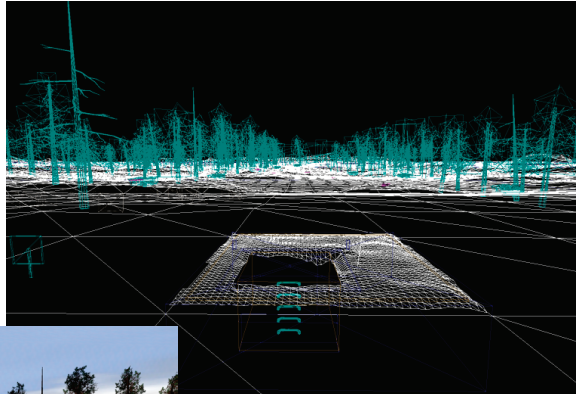
Medic training—all play and no work makes Jack a bad soldier

From Frame...

The photograph at right shows the prepared-fighting position for firing-point nine on red-range one at Ft. Benning, Georgia.



The same view reconstructed in the game editor (modeled with foxhole cover removed). Below, the model imported into the editor and skinned.



Below, the range as seen in the game.

Note that in the previous screenshot the red targets were lying behind black mounds. The script pops them up at the appropriate time.



...to Game



Was it hard to convince the brass? Not really. Nor was much demographic research required. Everyone knows young men aged eighteen to twenty-four play videogames and that they have to learn a lot in

order to play them successfully. Use of the military as a gaming premise was tried and true, having been explored by industry for years. No need to reinvent the wheel, but only to hire master wheelwrights.

The Army did have a requirement: that the game be played absolutely straight, as an honest representation of the service, especially regarding ethics, codes of conduct, and professional expectations, and extending

to accurate depiction of hierarchy, missions, weapons, equipment, uniforms, settings, discipline, tactics, and procedure. In short, this was to be a game a platoon sergeant could play without wincing.

This square-shooting obviated the usual marketing flurries. For one thing, the goal was modest: not persuasion, but education; the game didn't have to part a fool and his money, it had merely to be played.

Second, AA was self-defining—that is, if a game were to give the player the experience of performing an infantryman's job, it would be a first-person shooter with team play based on real missions (themselves inherently dramatic and easily adaptable), in which the primary design constraints are training prerequisites, the Army's code of conduct (including consequences for infraction), and a teen rating.

ALL PARTIES UNDERSTOOD that setting the right tone was key to avoiding public-relations disaster. The Army could not be perceived as celebrating trigger-happy Rambos, nor, by downplaying lethal force, be guilty of deceit and hypocrisy; must not pander to the testosterone of the demographic, yet must keep teens engaged; must avoid charges of jingoism, mesmerism, cynicism, cliché,

exploitation of vulnerable youth, incitement to violence, or a hundred other incorrectnesses.

In light of these constraints, the Army, having stated their objectives, had to invest a great deal of trust in the sincerity and comprehension of the ragtag crew building AA. One postmodern excess and the game was up.

The technical front was assigned to Zyda, and a team was scouted. Here AA hit on very good fortune. Alex Mayberry, tapped for creative director (and subsequently executive producer), was the disaffected veteran of eight years in the industry. He knew how games were built and wanted to build them better; towards that end he hand-picked a team as much for collaborative attitude as competency (see the roster at movesinstitute.org/team).

The Army supplied Lt. Colonel George Juntiff as design consultant, an on-site proofreader for both particulars and look and feel, and made soldiers available for interview. The MOVES Institute contributed a raft of master's and doctoral students (all of them military officers), whose emergent re-

search, including streamlined graphics algorithms and analysis of the psychological dynamics of immersion, was piped into the game.

WORK BEGAN as Wardynski and the designers roughed out the contents of the levels. The activities agreed upon were at once authentic, technically feasible, and fun—or made fun. Take the radio-tower mission: yes, rangers would disable the tower in real life, but they might do that by blowing it up—which would be over too quickly in a game. Instead AA requires the player to find friendlies, take down terrorists, and safeguard foreign-aid workers till the communications people can effect a takeover.

Missions the gamers thought exciting but the Army judged irregular were rejected, and elements the Army wanted but the team couldn't build to their own satisfaction were shelved for later. For example, while a parachute jump is in the game, a beach landing is not, because recreating water's splash and flow is extremely hardware intensive. Similarly,

ropes used dynamically in knotting and casting are currently more trouble than they're worth. But AA is continually under improvement and expansion. As the game engine evolves and consumer equipment improves, it will be possible to animate the Strykers and other vehicles that players can presently climb into and sight and shoot from; for now, they would move too slowly, look too crude, and require too vast a background.

THE TRIUMPH OF AA is that it manages to grip an action-oriented audience while insisting on a formal, educative structure. As every general started with boot camp, so also in AA you earn access to online play by paying your dues in basic training (thus experiencing the Army's merit-based promotion) and qualify for good stuff like marksman, airborne, and medic through advanced classes. Basic teaches you to think Army-style (forget shooting your drill instructor) and provides a handy space for learning how to maneuver before joining online play. The very pace of play, which is deliberate com-



Raw motion-capture video of a soldier stalking with an M-16

pared with other shooters, reminds the player that the Army proper is not a game.

To convey Army core values (loyalty, duty, respect, selfless service, honor, integrity, and personal courage), AA rewards soldierly behavior and penalizes rotten eggs. This works out in practical ways. In basic training, for example, you can opt to become a combat lifesaver. Doing so reflects duty and selfless service, so you get points and expanded opportunities for going through training. Out on mission, your buddy collapses in front of you. You can attend him, which earns points for loyalty and honor, or keep running, which

scrubs points. If you do stop, you become a target yourself, which takes courage, and if you're hit, your health will suffer, so you need the integrity to inform your actions with sound judgment. Doing your duty and saving both your lives wins the most points. Just like in combat.

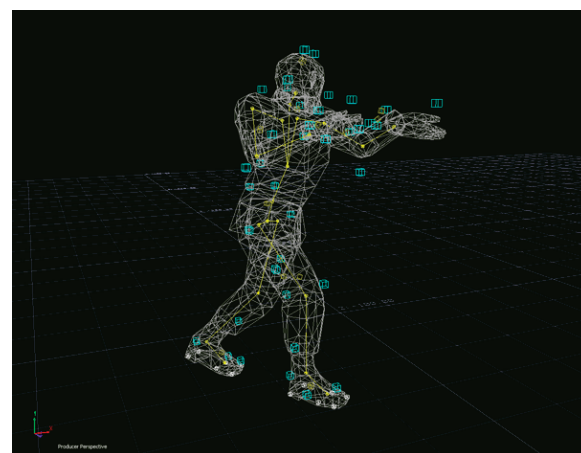
For the first release (July 2002), ten levels were agreed on and a shopping list drawn. Over the two years beginning in May 2000, the team visited nineteen Army posts, including Ft. Benning (for the rifle range), Ft. Lewis (weapons), and Ft. Polk (vehicles and house-clearing operations). Besides photographing modeling and texture

referents, shooting motion-capture video for animations, and recording thousands of sound effects, the team jumped from towers, submitted to dog attacks, even rode a Blackhawk helicopter at three a.m., watching the fireworks as live shells barraged the terrain below.

These first-person encounters gave the team an enthusiasm and sure-footedness that mere

hundreds of common and military assets—were built to translate reality into gaming levels.

CHARACTER modeling began with the assumption that the player will always see himself and his team as American soldiers and his opponents as terrorists. He can choose from three skin tones (with vaguely concomitant facial fea-



Editing the data in the motion-capture editor

stock footage and cold data could not provide.

Back home, the artists sorted through stills and b-roll, posting the likeliest to the network for perusal by the modelers and level designers. Virtual sets, consisting both of Army-post reproductions and fabricated hamlets and landscapes—together with

tures), but otherwise he's a young, midsized man, as is his generic and randomly-complexioned enemy. As roles for women are added to the game, so also will female avatars.

Players distinguish each other by dress, gear and weapons: the Americans in regulation uniforms, rucksacks, and helmets, the terrorists in black,

drab, or tiger stripe, with perhaps bandannas or caps. Both sides wear the paraphernalia appropriate to their weapons and combat roles, detail that is lost on many players, but which adds depth for the observant.

EXTENSIVE, continually updated weaponry is an AA distinction. Modeled from high-res orthographic shots with as much refinement as a 2,000-polygon budget permits, weapons are employed logically and strategically; a grenadier who tried to conduct himself like a sniper would suffer decreased combat effectiveness, as would a sniper shooting on the run.

To ensure equal advantage, much investigation went into matching up rival weapons. Where the Americans employ M-16 assault rifles, for example, the enemy carries AK-47s, the nearest real-world equivalent, with the AK-47's higher caliber and firing rate duly reflected. You can capture and fire enemy weapons, which results in twisty visuals: if you drop your M-16, the other side sees you drop an AK-47, and if they pick up your weapon, they see it as an AK-47 and you see it as an M-16 that fires like an AK-47. This isn't a bug, but a conundrum proceeding from the premise that though you've captured a weapon with a faster firing rate, all your weap-

ons will look American to you.

FOR ANIMATIONS, soldiers were rigged with motion-capture sensors and filmed enacting common operations (see plates 6 through 8 below). Procedures such as erecting a bipod or pulling and throwing grenades were performed strictly according to doctrine. The resulting sequences are truly tutorial—in fact, they've been used as such at West Point.

Where absolute adherence to reality would bog down the game (e.g., if running or jam-clearing were depicted at true speed), animators relied on cropping and streamlining to reconcile veracity with the need to sustain excitement, stepping frame-by-frame through motion-capture video to identify key postures and weed out intermediate movement, allowing the eye to jump as with a flipbook.

Artificial limitations on avatar range of motion were sometimes imposed to keep actions onscreen. In a reloading animation, for instance, the weapon is held at chest level (rather than dropping

to midsection) and the hands stay clear of the player's view. The illusion of free and fluid sweep depends, in such cases, on confinement and restraint.

AUGMENTING his MOVES research in auditory psychophysics with extensive consultation with entertainment's top audio designers and engineers, AA sound designer, Lt. Commander Russell Shilling, engineered the complex, multilayered sound that supports the game's immersive punch.

To determine the importance of audio in evoking emotion within videogames and simulations, Shilling's graduate students conducted research in three areas, with measures relying on objective rather than subject observations of performance enhancement. First, to ascertain the direct role of sound in creating presence and emotion, physiological responses (heart rate, respiration, electrodermal response, etc.) were measured [Scorgie and Sanders, 2002]. Auditory task analyses determined what sounds were requisite in the videogame for a realistic experience to occur [Greenwald, 2002].



All dressed up and somewhere to go: skinned, equipped, and animated online

Sunset at the oasis: a stormy AA atmosphere. Engineered as a dome over the midground, AA's evocative skies convey depth and immensity. On clear nights, the stars twinkle faintly, as with great distance.



Finally, it was shown that by heightening emotional aspects of game play, performance on memory tasks is enhanced [Ulate 2002].

Professional techniques for sound mixing and enhancement were brought to bear, with sound effects, weapons foley, and ambient sounds custom recorded or obtained from professional libraries. Weapons animations, for example, are accompanied by detailed and accurate audio representations enhanced for visceral impact and perceived realism. Footsteps, bullet impacts,

particle effects, grenades, and shell casings are accorded texture-specific impact noises and room acoustics are represented using Creative Lab's EAX 3.0 technology.

In a typical AA firefight, bullets whiz and crack by the player's ear, slam into the wall behind, and tinkle concrete and glass fragments at his feet. The player hears his shell casings thunk off the wooden door-frame behind him and ping the concrete floor. Meanwhile, to the clatter of a nearby reload, the enemy creaks across a steel catwalk over-

head. The player hears a flash-bang grenade scud off the floor behind him just before being incapacitated by the roar and ring of tinnitus in his ears. This scrupulous audio won the game prestigious Dolby Digital 5.1 Surround Certification and approbation from industry reviewers.

IN THE REALM of programming, realism was pursued through careful attention to game physics. When shooting, for example, the weapon sways slightly with the avatar's breathing, recoils on discharge, and occasionally

jams. Bullets penetrate or ricochet depending on the makeup of the target (e.g., wood, adobe, dirt, glass, or steel), distance from target, and the weapon's caliber, type, and firing velocity. The target's composition also determines depth of penetration, and distance and angle of reflection. For naturalism, the spray patterns produced by multiple shots are randomized within a logical ambit so as to spread believably.

Realistic physics inevitably influence players' decision-making. For instance, because rico-

chets tend to travel along vertical surfaces, players learn to resist hugging walls if they want to stay healthy and combat-effective, and they don't detonate a blinding, deafening flashbang at close range if they value seeing and hearing. While it's faster and more fun to charge around shooting from the hip, AA gives big points for zooming in and aiming through the sights and rewards shooting from stable postures such as crouched and prone. As on the battlefield, friendly fire is an inevitable reality, and you can't escape its penalties.

Mortal flesh can expire quickly in AA. If you're shot, fifty percent of your health is at risk: twenty-five percent up front plus another twenty-five percent that will drain away without medical help. If you are patched up, your combat effectiveness rises, because presumably you can still shoot.

Where reality is compromised, it's generally where literalness would give poor returns next to the engineering and byte-grinding involved. For example, straight vectors substitute for accurate ballistics in the case of fast-firing weap-

ons like the M-16, where the eye can't follow bullet trajectories anyway; but for grenade launchers and other big, slow ammo, virtual gravity is switched on to create accurate flight paths, and shooters must aim accordingly. Similarly, sound fidelity loses out in the case of shellfire from a Stryker: whereas from inside the real thing you can't hear the gun's report, in the game, a big bang is just plain obligatory, and therefore dubbed in.

Because terrain datasets in the game were larger than normally supported by the Epic engine, extensive research relating to terrain-rendering algorithms was conducted—but these algorithms were found unsuitable for the system due to hardware requirements, task limitation, or inefficient memory management [Greenwald, 2002]. These limitations were addressed by modifying

the original terrain algorithm to include multiple levels of detail for complex terrain. This method raised new issues with projected textures, transparent textures, and multi-resolution rendering; to address these concerns, the implementation technique includes resolutions to address them specifically. The world editor was also modified to give world designers control of these details.

Performance tests showed that this terrain level of detail system significantly improved display times, allowing greater terrain complexity while maintaining interactive frame rates. Rendering times in environments with small terrains improved almost forty percent, while large complex terrain environments (km² at 1m resolution) fared even better.

As the project progressed, the Army realized the

game had the potential for a much larger scope than originally conceived, including use of helicopters. Unfortunately third-person perspective helicopter physics were not included in the game engine nor AA's initial design. MOVES thesis students employed Unrealscript to design a physics system that interfaces with the Unreal engine and interpolates smoothly among physics states within the bounds of helicopter capabilities and the appearance of realism [Perkins, 2002]. In testing, fifty-three percent of subjects thought the helicopter physics were very or totally realistic, and seventy-two percent found them better than those on commercial graphics systems. In a follow-up study, eighty-six percent of participants found the helicopter physics equal to or better than those of a high-quality commercial 3D helicopter.



The MOVES Institute, developer of America's Army, conducts research and education in the grand challenges of modeling, virtual environments and simulation. See movesinstitute.org.

LIKE ALL GAMES, AA suffers its share of soreheads and hackers among the players. To deal with bad behavior, the Army contracts HomeLan for round-the-clock server-administration coverage, through which users can file complaints

and call server admins to enforce civility. Within the game, major offenses such as shooting civilian targets or your own team, or in some cases destroying an objective you are charged to defend, trigger a non-negotiable sentence to Ft. Leavenworth. The AA programmers originally combated hackers and cheaters themselves, but the next update will unleash Punkbusters software to continuously detect hacked game files and lock offenders out.

AA's insistence on getting the Army right implies unlimited potential for expansion as the game evolves and occupations and missions accumulate. The game's fan sites (americasarmy.com/community.php) reveal diverse interest in both the game *per se* and as it relates to the real Army, an encouraging sign that an ever-wider range of individuals will sign on in future releases. AA's achievement in building an online community will provide future opportunities for social scientists to study the correlation between gameplay, recruitment, and Army career success over the lifespan of the game.

TALK TO THE TEAM, and you'll soon uncover their deep respect for the men they encountered in making the game. As art director Phillip Bossant put it, "I got to know these guys. More and more my motivation for excellence is to honor them and the job they do. Guys helped us, gave us their time, who are now dead. The game is our tribute to them."

BESIDES adrenalinated reviews and features, America's Army: Operations continues to collect trophies, including Action Vault's *Debut Game of the Year*, *Surprise of the Year*, and honorable mention *Multiplayer Game of the Year*; Frictionless Insight's *Best Business Model (Developer) at E3*; IGN Editors' Choice Award for first-person shooters; IGN's *Biggest Surprise of E3*; Gamespy's *Best PC Action Game* runner-up; Penny Arcade's *Best Misappropriation of Taxpayer Dollars Ever*; Wargamers *Best of Show*, first-person/tactical shooters; Well-Rounded Entertainment's *Best of E3 2002*; DoubleClick's Insight Awards, honorable mention, *Best*

Multi-Channel Marketing Campaign; Academy of Interactive Arts and Sciences, finalist, *PC First Person Action Game of the Year*; and Computer Gaming World's *Editors' Choice*.

References:

Greenwald (2002). *An Analysis of Auditory Cues for Inclusion in a Virtual Close Quarters Combat Room Clearing Operation*. Master's thesis. The Moves Institute, Naval Postgraduate School. Monterey, 2002.

Perkins, K. (2002) *Implementing Realistic Helicopter Physics in 3D Game Environments*. Master's thesis. MOVES Institute. Naval Postgraduate School, Monterey, 2002.

Sanders, R., and Scorgie, R. (2002). *The Effect of Sound Delivery Methods on the User's Sense of Presence in a Virtual Environment*. Master's thesis. MOVES Institute, Naval Postgraduate School. Monterey, 2002.

Ulate, S. (2002). *The Impact of Emotional Arousal on Learning in Virtual Environments*. Master's thesis. MOVES Institute, Naval Postgraduate School. Monterey, 2002.

Shilling, R. *Contribution of Professional Sound Design Techniques to Performance and Presence in Virtual Environments: Objective Measures*. Proceedings of 47th Department of Defense Human Factors Engineering Technical

Advisory Group Meeting, San Diego, 2002.

Shilling, R. *Entertainment Industry Sound Design Techniques to Improve Presence and Training Performance in VE*. European Simulation Interoperability Workshop, MSIAC M&S Journal. London, 2002

Shilling, R., Zyda, M., Wardynski, C. *Introducing Emotion into Military Simulation and Videogame Design: America's Army: Operations and VIRTE*. Proceedings of the GameOn Conference. London, 2002.

Zyda, M., Mayberry, A., Wardynski, C., Shilling, R., Davis, M. *The MOVES Institute's America's Army: Operations Game*. Proceedings of ACM SIGGRAPH 2003 Symposium on Interactive 3D Graphics. Monterey, 2003.

Zyda, M., Hiles, J., Mayberry, A., Wardynski, C., Capps, M., Osborn, B., Shilling, R., Robaszewski, M., Davis, M. *Entertainment R&D for Defense*. IEEE Computer Graphics and Applications. January/February 2003.